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HYPOTHESIZING THAT CONGENITALLY BLIND ADULTS WOULD SCORE LOWER ON TESTS OF ABSTRACTION THAN ADVENTITIOUSLY BLIND OR SIGHTED ADULTS, THIS STUDY TESTED 25 CONGENITALLY BLIND, 25 ADVENTITIOUSLY BLIND, AND 25 SIGHTED SUBJECTS. THE WECHSLER ADULT INTELLIGENCE SCALE (WAIS) VOCABULARY TEST WAS ADMINISTERED TO EACH GROUP AND RESULTS SHOWED NO SIGNIFICANT DIFFERENCE IN INTELLECTUAL LEVEL AMONG THE GROUPS. SUBJECTS WERE TESTED BY THE WAIS SIMILARITIES TEST, THE PROVERBS TEST, THE KAHN TEST OF SYMBOL ARRANGEMENT, AND THE NUMBER SERIES COMPLETION TEST. MEAN SCORES FOR THE CONGENITALLY BLIND WERE THE LOWEST OF THE THREE GROUPS IN THREE OF THE FOUR TESTS OF ABSTRACTION, THEREBY SUPPORTING THE HYPOTHESIS. ON THE NUMBER SERIES COMPLETION TEST, THE ADVENTITIOUSLY BLIND GROUP SCORED SIGNIFICANTLY BELOW THE SIGHTED GROUP, PERHAPS BECAUSE OF THE IMPORTANCE OF VISUAL IMAGERY ON THIS TEST. RESULTS REVEALED THE AGE OF ONSET OF BLINDNESS AS AN IMPORTANT FACTOR IN THE INTERPRETATION OF TEST SCORES. INCLUDED IS A 79-ITEM BIBLIOGRAPHY. THIS DOCUMENT IS ALSO AVAILABLE FROM THE AMERICAN FOUNDATION FOR THE BLIND, 15 WEST 16TH STREET, NEW YORK 11, NEW YORK, FOR $0.90. (DF)

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ABSTRACT FUNCTIONING IN THE BLIND

EC 000 239

by EDMUND JOSEPH RUBIN, Ph.D.

AMERICAN FOUNDATION *for the Blind*

ABSTRACT FUNCTIONING IN THE BLIND

By
Edmund Joseph Rubin, Ph.D.

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Foreword

The question of differences in functioning between the congenitally blind and those who become blind later in life is one which frequently is debated. However, the amount of scientific investigation of this question has not been too extensive.

The present monograph is based on a doctoral dissertation entitled *The Performance of Totally Blind and Sighted Subjects on Tests of Abstraction,* which was submitted to the Department of Psychology at Fordham University in 1963. The primary purpose of the study was to test the hypothesis that congenitally blind adults would have lower scores than sighted and later-blind subjects on selected tests of abstraction.

The American Foundation for the Blind appreciates the opportunity to add this valuable study to the literature available for students in this field. We are grateful to Dr. Rubin for his permission to publish it.

M. Robert Barnett
EXECUTIVE DIRECTOR

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The author wishes to express his sincere appreciation to Dr. Jeanne Gilbert and Rev. William C. Bier, S.J. under whose direction this study was undertaken and whose patient guidance was so beneficial to its execution. He would also like to thank Dr. John Walsh for his assistance with the statistical analysis. He is especially grateful to Rev. Richard McGuinness of the Mount Carmel Guild for the Blind and to Miss Elizabeth Maloney of the Industrial Home for the Blind for their help in finding subjects for this study. He is indebted to those persons who so willingly gave of their time to serve as subjects for this investigation.

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CHAPTER I

Introduction

Blindness has always been a handicap which has aroused a great deal of pity and maudlin sympathy. Only recently have attempts been made to integrate the blind as full-fledged members of society. Even so, strong vestiges of past stereotyped thinking about the blind still remain, and the need for careful scientific study in this area is a very pressing one. A topic which has not received too much attention in the scientific literature is the comparison of the abilities of early-blind and those who become blind later in life.

RESEARCH STUDIES

The comparison of the early blind or congenitally blind with those who had become blind later in life has always been of interest to those working in this field. Carroll (1961) stressed the need for research on this particular question. According to him there is a qualitative difference between these two groups, and he emphasized the importance of bearing in mind such a distinction when making any effort toward the rehabilitation of the blind. Lowenfeld (1955) also maintained that not enough attention has been paid to distinguishing between these two groups.

The dearth of research comparing the performance of the early blind and the later blind is most evident. There were some studies in the area of maze learning which not only compared the performance of blind and sighted subjects, but also took into consideration the duration of visual experience prior to the onset of blindness. Koch and Ufkess (1926) confirmed an earlier observation of Carr (1921) that blind subjects needed more trials and made a greater number of errors on a stylus maze than a sighted group matched for age and intelligence. Knotts and Miles (1929)

in a later study obtained conflicting results in that they found that blind subjects attained consistently higher scores than sighted ones on both finger and stylus mazes. Lack of adequate controls for intelligence and degree of blindness could have caused the discrepancy in results. Duncan (1934) found little difference in the performance of a sighted and blind group on a finger maze, but in this particular study only three of the 30 blind subjects had complete loss of sight. More recently MacFarland (1952) reported that the maze learning ability of a group of blind adults was somewhat below that of a sighted group, but no indication was given of the intellectual ability of the groups. The failure to control for intelligence may well have influenced the results, and casts doubt on the acceptability of the conclusions.

In general, then, the evidence is inconclusive with respect to the relative performances of blind and sighted subjects on maze learning tasks. However, studies in this area have found that excellence of performance depended to some extent upon the degree of vision and also upon the duration of visual experience prior to the onset of blindness. Early blinded subjects showed some inferiority to later blinded ones on maze tasks.

Worchel (1954) and Drever (1955) conducted investigations with blind and sighted subjects on complicated haptic tasks. The former studied the performance of totally blind and sighted subjects between the ages of 8 and 21 on such tasks as reproducing and giving verbal reports of simple geometric forms and on tests of spatial orientation. An original task devised in this study was to present one part of a geometrical form to one hand of the subject and the second part to the other hand. The subject's task was to pick from four larger forms what the completed figure would be like. On almost all the tasks the performance of the sighted group was superior to that of the blind. Only on the recognition of forms did the latter obtain a higher score. The results also brought out the fact that later-blinded subjects surpassed the congenitally blind ones on many of the tasks.

Drever (1955) conducted a similar study and confirmed many of the previous findings. The subjects in this study were between 12 and 19 years of age. The results showed the later-blinded individuals to be much superior to early-blinded ones on tasks of

form recognition and in spatial orientation. Only in Drever's study was some attempt made to control for intelligence.

Axelrod (1959) investigated the performance of a group of 82 school children with blindness of early onset and a group of 82 sighted children on different tasks which included two-point thresholds on fingers of the preferred hand, two complex tactile tasks, and a complex auditory one. The tests employed were developed at the Psychophysiological Laboratory of the N.Y.U.-Bellevue Medical Center and had been used in previous research with sighted adults having brain lesions (Teuber, Battersby, & Bender, 1951; Teuber & Bender, 1951; Weinstein, Teuber, Ghent, & Semmes, 1955).

The two groups of subjects in Axelrod's study were matched for chronological age, and only children with vision no better than light perception were included in the blind group. There was no significant difference between the mean mental ages of the two groups. The results showed that the blind group's performance was significantly below that of the sighted on all of the complex tasks, including the abstract one. A smaller group of later-blinded children was also included in this study, "later blindness" being defined as occurring sometime after age two. The scores of the groups were adjusted by means of analysis of covariance for differences in chronological age and also mental age, and the results brought out that the later-blind subjects did not differ significantly from the sighted group on the abstraction or matching tasks.

Axelrod (1959) was of the opinion that these results were consonant with theories stressing the importance of early visual learning for later problem solving. He cited earlier studies with animals (Hebb, 1949; Hymovitch, 1952; Forgays & Forgays, 1952; Forgus, 1954) which had given indications that rich early experience, especially of a visual nature, conferred a definite advantage in the subsequent performance of animals on different tasks. However, he did point out the danger of extrapolating from animals to blinded humans.

Hayes, who has done the most work in testing the blind, reported in one study (Hayes, 1941) that blind children up to age 18 tested lower than the seeing in all of the Binet items which one

could classify under thinking or reasoning. In a later investigation Hayes (1950b) found that blind students between the ages of 10 and 17 received lower scores than the sighted on the Similarities subtest of the Wechsler-Bellevue Intelligence Scale. Between 17 and 24 these differences tended to disappear, but no indication was given of the age of onset of blindness or degree of blindness in either of these studies.

On the other hand, Levine and Blackburn (1950) tested a group of newly blinded soldiers with the Verbal Scale of the Wechsler-Bellevue Intelligence Test. The results were compared with the findings of a previous study (Herrman & Hackman, 1948) using sighted soldiers and very few differences were found. The small differences which did occur were in favor of the blind group. In Levine and Blackburn's study the highest scores obtained by the blind were on the Comprehension and Similarities subtests.

CONCLUSIONS FROM RESEARCH FINDINGS

The review of the literature thus indicated that little attention has been paid in research in this field to the distinction between the congenitally blind and the later or adventitiously blind. Lowenfeld (1955) claimed that the failure to make this distinction could be responsible for the ambiguity in the results of many studies and for contradictions between the results of others. Carroll (1961) decried the fact that many agencies working with the blind fail to make this distinction. He emphasized the fact that the adventitiously blind person forms his ideas about reality mainly according to a visual pattern. On the other hand the congenitally blind individual forms his ideas in a different way, so that his knowledge of the object world is built up in ways that are essentially different from those of the seeing individual and the later-blinded person.

The congenitally, totally blind person has to rely on the remaining senses to gain a concept of the world around him. Lowenfeld (1950) laid stress on the limitations of tactual, auditory, and kinesthetic experiences as compared with visual ones. The range and variety of concepts for the blind are restricted in many ways. Direct contact being necessary for tactual experience places the blind at a definite disadvantage; some objects are too large to be

tactually observed *in toto,* others are so small, tender, or fragile that they cannot be touched. Objects in motion, live objects, and objects under certain conditions, such as burning or cooking, do not lend themselves to observation by touch.

These are just a few of the limitations placed on the blind child in the process of gaining concepts of the environment around him. Sight on the other hand, is a unifying agent which enables the normal individual in a short time to observe a situation *in toto* and to combine part experiences into wholes. Lowenfeld (1955) also described sight as being an organizer of discrete experiences and as facilitating the reduction of form varieties to simpler patterns or schemata.

Cutsforth (1951) is another writer in the field who stressed the great deprivation that occurs in the congenitally blind child and the fact that his sensory equipment and processes of observing are organized quite differently from those of the sighted child. Chevigny and Braverman (1950) made the point that a true, separate philosophy of the blind could only be applied to the congenitally blind and that there are many deficiencies in our understanding of the organization under which this group functions.

Omwake and Solnit (1961) hypothesized that the congenitally blind child has considerable difficulty in transforming perceptual experiences into mental representations, and obstacles to the development of a capacity to organize and store such psychic representations are thereby created. According to their hypothesis concept formation would be late in developing in the congenitally blind. Hayes' findings (1941, 1950b) and Axelrod's study (1959) could serve in some ways to confirm such an hypothesis. The question comes up as to whether or not such deficiencies or lags in the development of mental functioning, particularly abstract ability, persist into adulthood.

PROBLEM

The review of the literature indicated the need for research with the blind, especially in the area of abstract functioning, and for this reason the present study was undertaken. Its purpose was to test the hypothesis that congenitally blind subjects would have lower scores than sighted and later-blind subjects on selected tests

of abstraction. The hypothesis was thus formulated because previous studies tended to show that the congenitally blind performed less efficiently than sighted and later-blind subjects on different tasks, for example, maze learning and complicated haptic tasks. In order to provide a valid test of the hypothesis comparable groups of subjects were used, that is, groups controlled or equated for the different variables which could affect performance on the tasks involved.

A supplementary aim was to determine the feasibility of using the tests of abstraction selected for the present study in future work with the blind. The need for tests suitable for use with the blind has been emphasized by different research workers.

CHAPTER II

Procedure

As had been mentioned previously, two factors which add to the difficulty of doing research with the blind are the heterogeneous population included under the term of legal blindness and the lack of suitable tests for use with the blind. The first factor ruled out the use of legal blindness as a criterion for selection of subjects for the blind groups in the present study. Specific criteria for degree of blindness, cause of blindness, age at onset of blindness, and duration of blindness, were established for the inclusion of blind subjects in the present study. It was also recognized that other factors could influence scores on the tests of abstraction. Therefore, attempts were made to control the groups for such factors as sex, age, education, socioeconomic level, and birthplace of parents.

For the present study it was possible to find two tests of abstraction, the Similarities Test and the Proverbs Test, which could be used with blind subjects without any modifications in the usual administration. Two other tests of abstraction, the Kahn Test of Symbol Arrangement and the Number Series Completion Test from the Army Alpha, Form 9, were selected, but alterations in the administration of these tests were necessary to make it possible to give them to blind subjects. The first two tests are verbal in nature, while the latter two are nonverbal tests.

The present chapter will first describe the groups used in the study and then deal with the various factors related to blindness and to performance on the tests of abstraction. The tests of abstraction and the administration of them will be covered in the latter part of this chapter.

Subjects

In order to determine what effects age at onset of blindness might have upon performance on tests of abstraction, two groups

of blind subjects and a group of sighted subjects were used in the present study. There were 25 subjects in each group. The first group consisted of those who had been totally blind since before age one and was designated the congenitally blind group. The other group, the adventitiously blind, was made up of persons who had become totally blind after the age of twelve. A third group composed of sighted people was included as a control group.

Congenitally Blind Group

The congenitally blind group consisted of those who had become totally blind before age one. Originally it had been intended to include in this group only those who had been totally blind since birth, but because of the limited number of subjects available some modification in this plan became necessary. It was therefore decided to include in the congenitally blind group individuals who had become totally blind up to age one.

Age one was chosen as the upper limit for the congenitally blind group in order to avoid the controversy concerning age at onset of blindness and retention of visual imagery. Lowenfeld (1955) maintained that useful visual imagery was not retained if blindness occurred before age five. From the results of his investigation Schlaegel (1953) claimed that a person does not retain visual imagery if blindness occurs before age three; when blindness comes between ages three and five, then visual imagery could remain in some individuals; and when loss of sight happens after age five, then visual imagery is retained. The last result is accepted by most investigators in the field. There has not been any evidence to indicate the retention of visual imagery when blindness occurs before age one, so it seemed justifiable to use this age as a criterion in the present study. However, as it turned out there were 19 subjects in this group who were totally blind from birth and six who had become totally blind sometime before age one.

Adventitiously Blind Group

Age twelve was established as the lower limit for age at onset of blindness in the adventitious group in order to have a clear differentiation between the groups as regards this factor, and also because most of the subjects would have completed a good part

of their formal schooling by age twelve. Appendix A lists the ages when each subject in the adventitious group lost his sight. Fourteen of this group became blind before age 20, nine between ages 20 and 30, and two between ages 30 and 35. The mean age at loss of sight for the adventitious group was 18.68 and the median was 16.00.

An important factor to be considered with the adventitiously blind group was duration of blindness. Almost all workers in the field of blindness recognizes the tremendous loss and the violent upheaval that come about with the onset of blindness. Carroll (1961) brought this point out rather vividly in his book, and he emphasized the point that such a blow does not signify the end of life but the beginning of a new type of living to which the newly blinded person must become adjusted. Since time is an important element in bringing about a satisfactory adjustment, it was decided to include in the adventitious group only those subjects who had been totally blind for a minimum of three years. Appendix A presents these data. Only two subjects had been blind for the minimum of three years, while one subject had lost his sight five years ago. Fourteen had been blind between six and fifteen years, and the remaining eight were blind for sixteen years or more. The mean number of years since onset of blindness for the adventitiously blind group was 13.12 and the median was 10.00.

Sighted Group

A control group of 25 sighted persons was also included in the present study. This group was composed of individuals who had volunteered to participate in the project and who were selected in accordance with the control factors set up to make the three groups in the present study comparable. The characteristics of the sighted group and the comparability of this group to the blind groups on the control factors will be treated in the latter part of the following section.

Comparability of the Groups

Cutsforth (1951) enumerated the many difficulties involved in obtaining comparable groups of blind subjects for research studies. The review of the literature showed that very few research studies

even attempted to take into account the many variables which arise when dealing with the blind. Some investigators, like Bauman (1954), first obtained large, rather heterogeneous groups of blind people, and then attempted to set up controls for the different factors involved. Others, like Dean (1957), tried to measure the effects of too many of the variables related to blindness, and, as a consequence, ended up with too few subjects who fitted into any one category. The conclusions deriving from such studies have been somewhat indefinite and ambiguous.

There seemed to be genuine need, then, for work to be done with comparable groups of blind subjects. By "comparable" was meant groups controlled or equated both for the different factors related to blindness and for the factors which could have an effect on the subject's performance on the task under investigation. Demonstrating that comparable groups of blind subjects could be obtained for research purposes was one contribution of the present study. Few previous investigations in the field of blindness had succeeded in controlling the relevant variables as well as was done in the present study.

Degree of Blindness

Perhaps the most important variable involved with research in the field of blindness is degree of vision. Many investigators have not attempted to control this factor too rigidly because of the difficulties entailed. The mere setting up of suitable criteria for degree of vision involves many difficulties. As mentioned in the previous chapter, the definition of legal blindness encompasses a very heterogeneous group. Therefore, it would not have been feasible to use the criterion of legal blindness if comparable groups of subjects were to be tested. Moreover, measurements of very low vision have proven to be somewhat inaccurate in some cases. It not infrequently happens that some people with very low vision make much better use of their sight than others with considerably more vision.

In order to ensure comparability the blind groups in the present study were specifically defined as regards degree of vision. Only those individuals were included who were totally blind or had light perception only. There were 23 in each of the two

blind groups who were totally blind, and two in each group who had light perception.

Cause of Blindness

Cause of blindness is a variable which has not received much mention in research studies in this area. It is possible that this factor could have an effect on mental functioning, especially if the etiology had its basis in damage to the central nervous system. In order to control for this variable, no subjects were included whose blindness was associated with central nervous-system pathology. Those whose blindness was caused by brain tumor, syphilis, or meningitis were therefore eliminated. Appendix B lists the causes of blindness for all the subjects. Some ophthalmologists are of the opinion that retrolental fibroplasia is associated with brain damage, but Norris, Spaulding, and Brodie (1957) found no evidence to support such a claim, so such cases were included in the present study. There were four subjects in the congenitally blind group who had retrolental fibroplasia.

Sex and Age

Two factors which could have some effect upon performance on tests of abstractions are sex and age. In order to rule out the possibility of differences in test scores being attributed to sex, only male subjects were used in the present study. The age range was between 18 and 49 years. The upper limit was established at age 49 in an attempt to avoid the problem of appreciable mental deterioration which can start in some individuals after age 50.

The mean ages of the groups are shown in Table 1. The adventitious group was slightly older than the other two groups,

TABLE 1

Mean Ages and Standard Deviations for the Three Groups

	Congenital	*Adventitious*	*Sighted*
Mean Age	31.00	32.60	30.16
Standard Deviation	10.79	9.04	10.30

but the differences in ages between the groups were not significant at the .05 level.

TABLE 2

Tests for the Significance of the Age Differences Among the Groups

	Mean Difference	*t*
Congenital vs. Adventitious	1.60	.57
Adventitious vs. Sighted	2.44	.89
Congenital vs. Sighted	.84	.28

Education

Another factor which could affect performance on tests of abstraction was number of years in school. From Table 3 it is evident that the groups were comparable as regards formal schooling and also that they were highly educated groups, each with a mean of more than 13 years in school. The means for the two blind groups were equal, while the sighted group had a mean which was less than half a year above the means of the other two groups. The standard deviations were also similar. The range in number of years in school for each group was as follows: congenitally blind group, 8 to 18 years; adventitiously blind group, 5 to 18 years; and sighted group, 4 to 18 years. These ranges were very similar, and thus gave further evidence of the comparability of the groups on this factor.

TABLE 3

Mean Number of Years in School and Standard Deviations for the Three Groups

	Mean Years in School	*Standard Deviations*
Congenital	13.32	2.49
Adventitious	13.32	3.67
Sighted	13.80	2.74

A heated controversy has raged for 25 years among workers in the field of blindness concerning the relative merits of residential as opposed to regular school in educating the blind. In 1948 close to 90 per cent of the blind children attended classes in residential schools. By 1957 the percentage had dropped to 60.

Since most of the subjects in this study began their formal schooling before 1948, it was almost inevitable that the congenitally blind would have attended residential schools. This difficulty was recognized beforehand, but the relative advantages of the two types of schooling have not been definitely established. No evidence has been found to indicate that academic training in a residential school has restricting effects on mental development, although the opinion prevails that social growth suffers because of the regimentation found in most schools of this type.

As it turned out, 21 of the 25 subjects in the congenitally blind group had spent some time in residential schools (see Appendix C). Of these, four subjects spent less than three years, while 16 spent between eight and twelve years in such a setting. The mean number of years in school in a residential setting for the whole group was 7.36 and the median was 8.00. On the other hand, nine of the adventitiously blind subjects attended classes in a residential school. The mean number of years in a residential school was 1.56 for the adventitious group. None of this group received his complete academic training in a residential school.

It was acknowledged that residential school training was a factor that could not be controlled because of the composition of the two blind groups to be studied, one being blind early in life and the other group after a good part of their formal schooling had been completed. However, the extent of schooling outside a residential school among the congenitally blind group in this study proved to be more than had been antecedently expected. The fact that 14 of the congenitally blind subjects were accepted as students in regular colleges, and seemed to have adjusted fairly well there, would tend to indicate that the number of years in a residential school did not have any adverse effects on the academic success of this group.

Socioeconomic Level

Another factor which many investigators consider as having some effect on mental functioning is socioeconomic level. Many authors and test constructors have used occupations as a measure of socioeconomic status. However, it must be remembered that although the blind are employed in almost all fields, there are

still many specific jobs closed to them. Moreover, Bauman (1954) found that blind persons require more mental ability than persons with useful vision in many occupations, and that there is a large number of highly intelligent blind people engaged in factory jobs. Since employment of the blind subjects would not be a valid measure of socioeconomic level, it was decided to use the main occupation of the fathers as an indication of this factor.

TABLE 4

Classification of Subjects According to Fathers' Occupation

	Congenital	*Adventitious*	*Sighted*
Occupational Categories			
I Professional and technical	3	3	1
II Managers, officials, proprietors	3	1	1
III Clerical and sales workers	6	4	6
IV Craftsman, foreman and operatives	8	11	11
V Service workers—public and private	3	3	4
VI Laborers	2	3	2

Table 4 shows the number of fathers in each occupational category for the three groups. The occupational categories were the same as those used by Terman and Merrill (1960) in the re-standardization of the Stanford-Binet. Inspection of Table 4 shows that the groups have a fairly similar distribution according to the fathers' occupations. In order to subject this distribution to a statistical analysis Table 4 was compressed into three levels by combining the odd-numbered levels with the next higher even-numbered one, in order to increase the cell entries. A Chi-square analysis was then employed to test the similarity of distribution, and the obtained Chi-square value of 2.79 was not significant at the .05 level, indicating that this variable had been satisfactorily controlled.

Birthplace of Parents

Having a foreign language spoken in the home during the early years of a person's life is another factor which could possibly influence performance on tests of abstraction. This factor was of

some importance in the present study, since three of the four tests used have a verbal component. Originally it had been planned to include only those subjects whose parents were native-born Americans, but because of the limited number of blind subjects available this restriction could not be carried out. Ten subjects in the congenitally blind group and ten in the sighted group had both parents who were foreign-born. Nine subjects in the adventitiously blind group came from a family in which both parents were foreign-born, while for one other in this group only the father was born outside the United States. In all 30 of these households another language, besides English, was spoken during the subjects' early childhood. The fact that there was an equal number of subjects, ten, in each group who did not have native-born parents, provided some control for this factor.

Tests

The limited number of tests available for use with the blind adds to the difficulty of doing research in this area. Dean (1957) has emphasized the need for more research with tests for the blind, and a supplementary aim of the present study was to investigate the value of the tests employed for future work with the blind.

Since Hayes (1941, 1950b) and Axelrod (1959) found that the performance of blind children was below that of sighted children on certain abstract tasks, the present study was undertaken to compare the performances of two groups of blind adults and a group of sighted subjects on tests which purported to measure abstract ability. Abstraction was taken to mean the ability to comprehend relationships and to react, not merely to concrete objects, but to concepts and abstract symbols, or to discern common elements in miscellaneous stimuli.

In order to gain some measure of abstract ability as thus defined, the following tests were used: the WAIS Similarities Test, the Proverbs Test, the Kahn Test of Symbol Arrangement, and the Number Series Completion Test. The WAIS Vocabulary test was also administered to each subject in order to obtain an estimate of intellectual level and statistical methods were employed to control for variations in this level among the three groups.

Similarities Test

The Similarities test, one of the subtests of the WAIS, consists of 13 paired words which are orally presented to the subject. The task is to describe how the paired items are alike. Each response receives a score of 2, 1, or 0.

Wechsler stated that "while a certain degree of verbal comprehension is necessary for even minimal performance on the Similarities test, sheer word knowledge need only be a minor factor" (1958, p. 73). He considered the ability to perceive the common elements of the terms being compared, and, at higher levels, the ability to bring them under a single concept, to be important for this test.

It has been shown by means of factor analysis (Cohen, 1952, 1956) that the Similarities test of both the Wechsler-Bellevue and the WAIS has at all age levels the highest loadings on the *g* factor. In so far as this factor is a measure of generalizing or abstracting ability, the Similarities test can be considered suitable as a test of abstraction.

Since vision is considered the relational modality par excellence, deprivation of this sense at a very early age would in many ways decrease the opportunities for learning relationships like identity, similarity, and difference. This is the reason why the Similarities test was included in this study even though a high correlation has been found between this test and vocabulary.

Wechsler (1955) reported reliability coefficients of .87, .85, and .85 at the different age levels used to compute the reliability of this subtest. In the present study reliability coefficients were likewise computed by correlating the scores on the odd and even items and correcting the coefficient for full length of the test by the Spearman-Brown formula. Coefficients of .80, .85, and .91 were obtained for the congenital, adventitious, and sighted groups respectively. Hayes (1942, 1943) used the Wechsler-Bellevue Scale with blind subjects and found the Similarities subtest to be an excellent test for this group. Because of the recency of the WAIS little research with the blind has appeared in the literature.

Proverbs Test

Gorham's adaptation (1956a, 1956b) of the Proverbs Test

was used in the present study. Since this test was administered orally to each subject only clinical Forms I and III were used, since giving all three forms in this manner would have been too time consuming. The individual has to give a meaning for each proverb, and there are 12 proverbs in each form. The responses are scored for abstraction on a three-point scale, with two points being given for an adequate answer, one point for a partially successful one, and zero standing for a complete failure. Scoring examples are found in the manual (Gorham, 1956b). In the present study the scores from the two forms were combined for each subject.

Gorham described the Proverbs Test as being "a rapid, objective method for appraising the level of abstract verbal functioning" (1956b, p. 1). He pointed out that the task of finding meanings for proverbs involved the conversion of concrete symbols into "verbal concepts" or "verbal abstractions," and can be considered as a measure of abstract functioning. A factor-analytic study (French, 1951) indicated that the Proverbs Test has a high loading of "verbal comprehension."

Gorham (1956a) obtained reliability data from intercorrelations between the three forms of the test. The correlations obtained between Forms I and III were .79 for a group of normal subjects and .84 for a group of schizophrenics. A test-retest reliability of .96 was found for Form I with a group of 30 schizophrenic patients (Gorham, 1956b). Gorham (1956a) also reported an interscorer reliabiliy of .95. In the present study correlation coefficients for the two forms of .79, .79, and .80 were obtained for the congenital, adventitious, and sighted groups respectively. An interscorer reliability of .96 was also obtaind for the congenitally blind group on the combined scores of Forms I and III.

Kahn Test of Symbol Arrangement

The Kahn Test of Symbol Arrangement consists of 15 plastic "culturally structured object symbols," such as hearts, stars, dogs, butterflies, an anchor, a circle, a cross, and a parrot. These objects differ in color, size, thickness, and translucence. A cloth strip containing 15 equal-sized, numbered segments is ordinarly placed down in front of the subject, and he is asked to arrange the objects

on this strip four times. In order to make the task possible for sightless subjects a wooden strip, the same size as the cloth one ordinarily used, and containing 15 equal-sized segments, divided from each other by recessed lines and numbered from 1 to 15 with raised numerals, was developed for the present study. A previous pilot study showed that arranging the objects on the cloth strip was too difficult without the use of vision. The substitution of the wooden strip for the cloth one was the only change from the original test material. Alterations in administration of the test were also necessary, and these will be covered in the next section of this chapter.

Scoring was done in accordance with the instructions in the manual (Kahn, 1956). Scores are computed for the reasons the subject offers for his first, second, and fourth arrangements of the objects, for the levels of symbolizing to the 15 objects, and for the reasons for liking and disliking six of the objects (the first three and the last three) on the third arrangement. This gives a total of 24 items which are scored on a nine-point scale, the highest score being given to the most abstract responses. Scoring examples are found in the manual (Kahn, 1956) and in a supplemental guide (Hedlund & Miller, 1960).

According to Kahn (1957) this test represents a unique approach to measurement of abstract ability. He described it as "a measure of willingness to accept and acknowledge abstractions which have been hand-tailored by the culture, as well as one of capacity to abstract" (Kahn, 1957, p. 101). Since this test is a nonverbal test, it provided a measure of abstract ability in a different area from the Similarities and Proverbs tests.

Test-retest reliability coefficients range from .66 on a group consisting of untreated mental patients (Kahn, 1957) to .95 when a normal group was used as subjects (Kahn, 1951). Since it was not possible to compute a split-half reliability coefficient for the Kahn Test, no reliability data were obtained for the groups in the present study. Kahn (1957) reported an interscorer correlation of .99 on 25 records with psychologically untrained scorers. In the present study an interscorer correlation of .98 was obtained for the records of the congenitally blind group. Cross-validation studies (Kahn, 1951, 1955) corroborated earlier findings that this

test could effectively differentiate between organic and nonorganic subjects. Another study (Kahn, 1957) provided evidence that the test could screen normals from psychotic groups.

Number Series Completion Test

The last test of abstraction was the Number Series Completion Test from the Modified Alpha Examination, Form 9. This test is one of the eight tests which comprise the most recent adaptation of the Army Alpha (Wells, 1943).

Brigham (1923) described this test as being the only one on the Army Alpha demanding a high order of intelligence almost entirely independent of the use of language. Recent factorial studies (Kettner, Guilford, & Christensen, 1959; Guilford, Merrifield, Christensen, & Frick, 1960) have found that tasks very similar to this one were significantly related to such factors as general reasoning and cognition of symbolic systems.

Since the Number Series Completion Test requires the discernment of relationships between objects, this time the objects being numbers, it was decided to include such a task in this study which was involved in comparing the performance of specific groups on tests of abstraction. The fact that this test was much less loaded with the verbal factor than the other tests in the study also made it appear to be a worthwhile addition.

On this test 20 sets of six numbers each are presented visually to the subject. Each set of numbers is arranged according to a certain rule. The subject's task is to discover how the numbers in each series are related to each other, and then write what two numbers come next. A three minute time limit is ordinarily employed with this test. Correct responses are scored only if the *two* numbers which follow are given. In this study it was not possible to administer the test visually, so the sets of numbers were presented orally to each subject. The administration of the Number Series Completion Test is described in the next section.

In order to obtain a correlation between the Number Series Completion Test as usually administered and the present adaptation, another form of this test from the Army Alpha Examination, Form 5, was given to the sighted subjects after they had finished the test battery. The correlation coefficient between the

visual administration and the oral presentation for the sighted group was .88.

On the original Army Alpha correlations of the Number Series Completion Test with the other tests in the battery ranged from .61 to .77 (Yerkes, 1921). The highest correlation was that with the Arithmetical Reasoning Test. The correlation between this test and Mental Age scores on the Binet-Intelligence Scale for 1000 pupils was .72. In the present study reliability coefficients were computed for the Number Series Completion Test by correlating the scores on the odd and even items and correcting for the full length of the test by the Spearman-Brown formula. Coefficients of .94, .75, and .82, were obtained for the congenital, adventitious, and sighted groups respectively.

Vocabulary Test

The Vocabulary test of the WAIS was employed to provide an estimate of the intellectual level of each subject. Mean vocabulary scores were thereby obtained for the groups, and these scores were compared to ensure that the groups were not significantly different from each other as regards intellectual level. It was necessary to obtain indications of the intellectual levels of the groups since marked differences among the groups on this factor would automatically produce discrepancies in scores on the measures of abstract ability, and a valid test of the hypothesis would not have been attained. The design of the present study therefore provided for equating the groups on the basis of intellectual level and then testing for differences in intellectual functioning, specifically abstract ability.

The use of the Vocabulary Test as an estimate of intellectual level has been employed in a number of research investigations. Examples can be found in some of the work on abstract ability in schizophrenics (Becker, 1956; Herron, 1960). Other examples are the "deterioration" tests, such as the Babcock-Levy Test (Babcock & Levy, 1940), the Hunt-Minnesota Test for Organic Brain Damage (Hunt, 1943), and the Shipley-Institute of Living Scale (Shipley, 1946), which compare vocabulary score with performance on other types of tests in order to gain a measure of intellectual deterioration. The rationale for this procedure is fundamentally

the distinction between vocabulary score, as a measure of intellectual level, and the other tests, as measures of intellectual functioning. This distinction is basically what was employed in the experimental design of the present study.

The WAIS Vocabulary test was therefore administered to each subject. This test consists of 40 words which the subject is asked to define. Each response is scored 2, 1, or 0, and scoring examples are given in the manual (Wechsler, 1955). High reliability coefficients of .94, .95, and .96, were obtained by the split-half method for the standardization groups. In the present study high reliability coefficients of .97, .96, and .95, were found by the split-half method for the congenital, adventitious, and sighted groups respectively.

Administration of Tests

The five tests were given individually by the author to each subject at one session. Testing time ranged from about an hour and twenty minutes to two hours. The inconvenience of travelling for the blind subjects necessitated completing the tests at one session even though the time may have been lengthy for some subjects.

Instructions in the WAIS manual (Wechsler, 1955) were followed for the Vocabulary and Similarities tests. The Proverbs Test was administered orally according to the directions in the manual (Gorham, 1956b).

Some modifications in the administration of the Kahn Test had been indicated as necessary in a previous pilot study with blind subjects. Ordinarily the subject is asked to name each of the 15 plastic objects used in the test. This requirement had proven to be a very difficult and lengthy task for blind subjects; for example, the plastic dogs, which are relatively simple for someone with vision to discern, proved to be rather formidable to name for someone who has to depend entirely on the sense of touch. In order to avoid making the task one of tactual perception the examiner named each object if the subject did not do so within ten seconds of picking it out of the box or named it incorrectly. After all 15 items had been correctly identified by either the subject or the examiner, they were replaced in the box, and

the same procedure followed through again. Then the subject was instructed to familiarize himself with the wooden strip as the examiner described it.

These were the only alterations in administration for this test, and the rest of the directions were given as outlined in the manual (Kahn, 1956). The subject arranged the objects the first two times and the fourth time according to whatever criteria he wished, and the third arrangement was according to his order of preference. After the second arrangement the subject was asked to symbolize to each of the 15 objects.

Meyerson (1953) cited as a weakness in the field of research with the blind the fact that often the methodology employed with blind subjects was different from that used with seeing subjects in the same experiments. The only one of the tests used in this study in which vision would play a direct role was the Kahn Test. Visual cues, such as color, could definitely influence the subjects' scores. In order to keep the administration the same for all the subjects and to prevent any group from having additional cues, the sighted group was blindfolded while taking this test and the same direction followed as with the blind subjects. This type of administration might penalize the sighted subjects because it entailed performing a task under unfamiliar conditions, but the need for the same administration for all the groups seemed to outweigh this factor.

The Number Series Completion Test was administered by means of a tape recorder in order to ensure uniformity of administration. Responses were given orally within a time limit, five seconds for the first ten series and ten seconds for series eleven to twenty. Both numbers had to be given within the allowed time (before the word "Stop" occurred on the tape) in order to be scored as one correct response. A similar form of this test, from the Army Alpha Examination, Form 5 was also given visually to the sighted subjects at the end of the testing session, in order to provide a correlation between the usual method of presenting this test and the one used in the present study.

CHAPTER III

Results

The purpose of the present study was to compare the performance of the two blind groups and a sighted group on four tests of abstraction. Since performance on these tests could be influenced by intellectual level, some consideration had to be given to the intellectual levels of the groups. The present chapter will first deal with the topic of equating the three groups with respect to intellectual level before considering the general results of the study. The results of each of the tests of abstraction will then be treated.

Control of Intellectual Level

As had been previously explained the WAIS Vocabulary test was administered to each subject in order to gain an estimate of his intellectual level. This test yielded scaled scores derived from the basic reference groups used in the standardization of the WAIS (Wechsler, 1955). The mean scores and standard deviations for the Vocabulary test are presented in Table 5.

TABLE 5

Mean Scores and Standard Deviations on the Vocabulary Test

	Congenital	*Adventitious*	*Sighted*
Mean Vocabulary Score	13.24	12.24	12.80
Standard Deviation	3.17	3.04	2.71

Wechsler (1955) found mean scores of 9.3, 10.2, and 10.1 and standard deviations of 2.8, 3.0, and 3.4, for three groups in the standardization sample. The present mean vocabulary scores were two and three points higher than those obtained by Wechsler, so the intellectual levels of the groups in the present study could

be considered to be above average. The standard deviations for the Vocabulary test were similar to the ones which Wechsler obtained.

As mentioned in the previous chapter the three groups in the present study were equated on various background factors. Because of the difficulty involved in equating the groups on all these factors, it was not considered feasible to attempt to match the groups as regards vocabulary scores. It was planned to equate the groups for vocabulary scores by statistical methods, namely analysis of covariance, since the experimental design required that the groups be equated as regards intellectual level. However, the mean vocabulary scores of the groups were close to each other as shown in Table 5 and more specifically in Table 6. The latter table shows that the differences between the groups on the vocabulary test were not signficant at the .05 level. Thus, the three groups could be considered comparable as regards intellectual level.

TABLE 6

Tests for the Significance of Differences on Vocabulary Scores

	Mean Difference	*t*
Congenital vs. Adventitious	1.00	1.14
Adventitious vs. Sighted	.56	.69
Congenital vs. Sighted	.44	.53

Nevertheless, it could not be disregarded that the tests of abstraction, especially the Similarities and Proverbs tests, have high loadings on the verbal factors. This fact was borne out by the following correlations between the vocabulary test and the tests of abstraction for the three groups in the present study: Similarities Test .64, Proverbs Test .74, Kahn Test .50, and Number Series Completion Test .48. In view of these correlations it was decided to retain the original plan of using the analysis of covariance as a means of accounting for the differences in vocabulary scores which did occur. This statistical technique was used to correct the final means on the tests of abstraction for the differences among the groups on the vocabulary test. A more sensitive

analysis of the data was thereby provided than if no consideration had been given to such differences in vocabulary scores.

General Results

Mean scores were derived for each of the three groups on all tests. The Similarities test yielded scaled scores derived from the basic reference groups used in the standardization of the WAIS (Wechsler, 1955). On the Proverbs Test each response was scored 2, 1, or 0 according to its level of abstractness, and the sum of the scores on Forms I and III gave the total score for each subject. In the Kahn Test the reasons offered for three of the arrangements of the objects, the level of symbolizing for the 15 objects, and the reasons for liking and disliking the first three objects and the last three in the second arrangement, a total of 24 scorings, were scored according to nine categories based on the level of abstractness of the response. The categories had numerical weighted scores (Kahn, 1957), and the sum of the 24 scores gave the total score for each subject. On the Number Series Completion Test a reply giving the next two numbers in the series correctly within the time limit was scored as one. The sum of correct responses made up the individual's total score on this test.

The unadjusted mean scores on the tests of abstraction are presented in Table 7. Inspection of this table shows that the scores

TABLE 7

Unadjusted Mean Scores and Standard Deviations on the Tests of Abstraction

	Similarities		*Proverbs*		*Kahn*		*Number Series*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Congenital	11.80	2.84	25.72	9.87	105.16	33.54	12.20	5.54
Adventitious	11.92	2.75	26.72	8.40	112.48	22.78	10.76	3.22
Sighted	12.40	2.60	29.92	8.62	111.56	18.59	13.64	4.14

obtained were in the hypothesized direction on three of the four tests, with the congenitally blind group having the lowest score. On the other hand, the sighted group had the highest mean score on all of the tests except the Kahn Test. On two of the tests, the Similarities and Proverbs, the relative positions of the groups

were the same, the sighted having the highest score, the adventitious group next, and the congenital group with the lowest score.

The mean scores on the Similarities test were higher than those obtained by the three age groups in the standardization sample of the WAIS. Wechsler obtained mean scores of 9.5, 10.1, and 9.0 and standard deviations of 3.1, 3.0, and 3.4 for the standardization groups. The means scores for the groups in the present study indicated that they were of above-average ability on this particular task. The standard deviations were lower than those obtained by Wechsler, thus indicating that the scores for the Similarities test were more homogeneous for the groups in the present study than for the groups in the standardization sample.

The mean scores for the groups on the Proverbs Test were higher than the mean score obtained by a group of 100 male subjects in the standardization sample. Their mean score was 11.5 for Form I (Gorham, 1956b), while in the present study the mean scores for Form I were 12.40, 12.40, and 14.18 for the congenital, adventitious, and sighted groups respectively. The higher mean scores for the groups in the present study gave further evidence of their above-average ability.

On the Number Series Completion Test the adventitiously blind group had the lowest mean score. The highest score on this test was obtained by the sighted group. There was a major alteration in the administration of this test; the numbers were presented orally to the subject instead of by the usual method of having the subject look at them. However, a correlation of .88 was obtained between the performances of the sighted group on the oral administration and on the visual administration. A correlation this high indicated that the two administrations are measuring similar abilities.

The mean score for the sighted group on the visual presentation was 12.20. When this mean was compared with the one obtained with the oral administration, it brought out the fact that the visual presentation was more difficult for the sighted group. The three-minute time limit employed with the visual administration may have played a more important role in increasing the difficulty level than the five and ten second time limits used in the oral presentation. Yerkes (1923) reported a median score of

6.42 for this test on the original Army Alpha Examination with 162,562 subjects. Breaking down the results of the original Army Alpha Examination, Yerkes reported median scores for this test as follows: 11.96 for 15,528 white, Army officers; 6.53 for 41,278 white, Army enlisted men; and 1.81 for 19,992 colored draftees. The mean scores of the congenital and sighted groups are above all the median scores reported by Yerkes. The adventitiously blind group had a mean score which was one point below the median score of the officers' group in the original sample of the Army Alpha, but this mean was much above the median scores reported for all the white and colored enlisted men. Thus, the groups used in the present study could be considered of above-average ability on the Number Series Completion Test. The standard deviations obtained for the present groups indicated a great deal of variability in the subjects' performances on this task.

The Kahn Test was the only one in which the sighted group did not have the highest score. The adventitiously blind had the highest score, with the congenitally blind having the lowest score. Alterations in the administration of the Kahn Test were necessary, but the method of scoring was the same as in the manual (Kahn, 1956). Kahn (1957) established classification levels from the data obtained in different studies with this test; those with scores between 90 and 110 were classified in the average normal group, and those with scores over 111 were in the superior normal group. According to these classifications the mean scores for the adventitiously blind and sighted would be in the superior group while the congenitally blind would be in the upper half of the average group. The groups in the present study may have been penalized because they were deprived of visual cues. One scoring category, color, was thereby entirely ruled out. Moreover, since some of the similarly shaped objects had different colors the tendency to give more than one symbolization to similar objects was lessened by the loss of visual cues, and the scores would thereby be decreased. When comparing the scores obtained by the present modification of the Kahn Test with scores obtained by the usual administration, the fact that visual cues were eliminated would have to be considered, and, therefore, that the scores obtained with the administration employed in the present study

might conceivably be lower than those obtained with the usual administration. The fact that the groups in the present study were able to do so well on the Kahn Test as compared with the norms, is a further indication of their superior ability.

It should also be pointed out that the sighted group was blindfolded for the Kahn Test and that working under these unfamiliar conditions may have penalized their performance. This contention is supported by the fact that the Kahn Test was the only one of the four tests of abstraction on which the sighted group did not have the highest mean score. Since the mean score of the adventitiously blind group on the Kahn Test was slightly above that of the sighted group, very probably the latter group would have obtained the highest mean score of the three groups if it had not been penalized by being blindfolded.

As already indicated, in order to equate the groups as regards scores on the Vocabulary test, analysis of covariance was used in the present study. The mean scores on the tests of abstraction were adjusted to account for differences among the groups on the Vocabulary test. Table 8 presents the adjusted means for the

TABLE 8

Adjusted Mean Scores on the Tests of Abstraction

	Similarities	*Proverbs*	*Kahn*	*Number Series*
Congenital	11.51	24.61	102.98	11.85
Adventitious	12.23	27.92	114.84	11.14
Sighted	12.38	29.83	111.38	13.61

four tests. The relative positions of the three groups on any of the tests did not change with the adjustment of the means. There was negligible difference between the unadjusted and adjusted means for the sighted group. The scores of the congenitally blind group decreased to some extent, while the adventitiously blind had slightly increased scores.

In general, then, there was some consistency in the results of the present study. In the first place, the congenitally blind group had the lowest mean score on three of the four tests of abstraction. Secondly, the relative positions of the groups were the same on

two of the tests, and if the explanation about the performance of the sighted group on the Kahn Test is accepted, then the relative positions of the groups would be the same on this test as on the other two tests, with the adventitiously blind group having the intermediate position between the sighted and congenitally blind groups. The results of the Number Series Completion Test differed from the other three tests in that the adventitiously blind group had the lowest mean score. Thus, only on the last test were the mean scores not in the hypothesized direction.

Results of Specific Tests

The results of the analysis of variance and the analysis of covariance for the data of each of the four tests of abstraction are presented in the following sections. The reason for using analysis of covariance in the present study was indicated previously.

In order to compare the performances of the groups on the tests of abstraction, it was decided to use "orthogonal" or "planned" comparisons (Cochran & Cox, 1957). Such comparisons not only provided a very discriminative means of investigating differences in the performances of the groups, but also were permissible in cases where a significant F ratio was not obtained in the analysis of covariance. The total scores for each group, adjusted for differences on the vocabulary test, were used in these comparisons. Since the hypothesis postulated that the congenitally blind group would do less well on the tests of abstraction than the adventitiously-blind and sighted groups, it was possible to combine the latter two groups for one of the comparisons. Therefore, the first orthogonal comparison was between the congenitally blind and those who were sighted or had sight sometime during their lives; the second one was between the sighted and those who had sight and lost it. The results of these comparisons for each of the tests of abstraction are also presented in the following sections. As the hypothesis specified the direction of the difference in performance, one-tailed tests for significance were used in the present study.

Results of the Similarities Test

Table 9 presents the results of the analyses of the data of the

Similarities test. Although there was an increase in the value of the *F* ratio for the adjusted data, no significance at the .05 level was found in either the unadjusted or adjusted data.

TABLE 9

Analysis of Variance for the Unadjusted and of Covariance for the Adjusted Data for the Similarities Test

Sources of Variation	*df*	*Mean Square*	*F*
Unadjusted:			
Treatment	2	2.52	.34
Error	72	7.47	
Total	74		
Adjusted:			
Treatment	2	5.31	1.23
Error	71	4.33	
Total	73		

The comparison of the difference between the adjusted total scores on the Similarities test of the congenitally blind group and the other two groups was not significant at the .05 level. There was also no significance between the difference of the adjusted total scores of the adventitiously blind and sighted groups. Table 10 presents these comparisons. The narrow range of scores due to the small number of questions on the Similarities test and to the limited discriminative ability of each response (score of 2, 1, or 0) probably decreased the sensitivity of this test to deficiencies in abstract ability for the groups in the present study.

TABLE 10

Orthogonal Comparisons Based on the Similarities Data

Comparisons	*Sum of Squares*	*F*
Congenital vs. adventitious and sighted	10.45	2.41
Adventitious vs. sighted	.26	.06

An interesting aspect of the results of the Similarities test was that 16 of the congenitally blind group had scaled scores two or more points lower than their vocabulary scores. Only nine in

the adventitiously blind group and eight sighted subjects had Similarities scores this much below their vocabulary scores. In order to investigate this point further a nonparametric technique, the Median test, was used with the similarities data (Walker & Lev, 1953). A Chi-square value of .84 was obtained, and although this was not significant at the .05 level, the fact that more of the congenitally blind group than the other groups had scaled scores on the Similarities test two or more points lower than their vocabulary scores was in line with the hypothesis.

Results of the Proverbs Test

Table 11 presents the results of the analyses of the data from the Proverbs Test. Although the *F* ratio for the unadjusted data was not significant, the *F* ratio for the adjusted data was significant at the .01 level.

TABLE 11

Analysis of Variance for the Unadjusted and of Covariance for the Adjusted Data for the Proverbs Test

Sources of Variation	*df*	*Mean Square*	*F*
Unadjusted:			
Treatment	2	120.34	1.49
Error	72	80.80	
Total	74		
Adjusted:			
Treatment	2	172.94	5.08**
Error	71	34.07	
Total	73		

** Significant at .01 level

TABLE 12

Orthogonal Comparisons Based on the Proverbs Data

Comparisons	*Sum of Squares*	*F*
Congenital vs. adventitious and sighted	302.91	8.89**
Adventitious vs. sighted	45.43	1.33

** Significant at .01 level

Table 12 shows that the difference between the adjusted total score of the congenitally blind group and the combined score of the other two groups was significant (at the .01 level). There was no significant difference between the adjusted total scores of the adventitiously blind and sighted groups.

Since the *F* ratio of the adjusted data was found to be significant, Tukey's test of all comparisons among means (Snedecor, 1956) was applied to the data. The adjusted mean for the congenitally blind group was found to be significantly below that of the sighted. The difference between the means of the congenitally and adventitiously blind groups was not significant at the .05 level. These comparisons are presented in Table 13.

TABLE 13

Multiple Comparisons Between the Groups on the Proverbs Data

	Adjusted Mean	$\bar{x} - 24.61$	$\bar{x} - 27.92$	*D*
Sighted	29.83	5.22*	1.91	3.98
Adventitious	27.92	3.31		
Congenital	24.61			

* Significant at .05 level

The results of the comparisons for the Proverbs Test clearly verified the hypothesis. The performance of the congenitally blind group was significantly below that of the sighted group, thus pointing to a deficiency in abstract ability, as measured by this test, in the congenitally blind group.

TABLE 14

Analysis of Variance for the Unadjusted and of Covariance for the Adjusted Data for the Kahn Test

Sources of Variation	*df*	*Mean Square*	*F*
Unadjusted:			
Treatment	2	397.46	.60
Error	72	663.14	
Total	74		
Adjusted:			
Treatment	2	913.20	1.87
Error	71	487.15	
Total	73		

Results of the Kahn Test of Symbol Arrangement

Table 14 presents the results of the analyses of the data from the Kahn Test. As in the Similarities test, there was an increase in the value of the *F* ratio for the adjusted data of the Kahn Test, but no significance was found in the unadjusted or adjusted data.

The difference between the adjusted total score of the congenitally blind group and the combined total of the other two groups was not significant at the .05 level. However, it should be pointed out that this difference approached significance since it was beyond the .10 level. The difference between the total scores of the adventitiously blind and sighted groups was also not significant. Table 15 presents these comparisons.

The scoring on the Kahn Test provided a finer discrimination for each response, and a broad range of individual scores was obtained. It should be remembered that the sighted subjects were blindfolded for the Kahn Test, and, therefore, working under

TABLE 15

Orthogonal Comparisons Based on the Kahn Data

Comparisons	*Sum of Squares*	*F*
Congenital vs. adventitious and sighted	1709.88	3.51
Adventitious vs. sighted	149.15	.31

unfamiliar conditions. This factor probably had some adverse effects on their performance, as was indicated by the fact that this was the only test on which the sighted group did not achieve the highest score. Thus, the fact that the difference between the congenitally blind group and the other two groups approached significance suggests that the level of statistical significance may well have been reached if the sighted group had not been penalized.

Results of the Number Series Completion Test

Table 16 presents the results of the analyses of the data for the Number Series Completion Test. The *F* ratios for the unadjusted and adjusted data of the Number Series Completion Test were not significant at the .05 level.

TABLE 16

Analysis of Variance for the Unadjusted and of Covariance for the Adjusted Data for the Number Series Completion Test

Sources of Variation	*df*	*Mean Square*	*F*
Unadjusted:			
Treatment	2	51.84	2.67
Error	72	19.39	
Total	74		
Adjusted:			
Treatment	2	40.38	2.72
Error	71	14.87	
Total	73		

The adjusted total score of the congenitally blind group on the Number Series Completion Test was not significantly different from the combined score of the other two groups. The difference between the adjusted total scores of the adventitious and sighted groups was significant at the .05 level. Table 17 presents the results of these comparisons.

TABLE 17

Orthogonal Comparisons Based on the Number Series Completion Data

Comparisons	*Sum of Squares*	*F*
Congenital vs. adventitious and sighted	4.60	.31
Adventitious vs. sighted	76.34	5.13*

* Significant at .05 level

The Number Series Completion Test was the only test whose results were not in the hypothesized direction. In this connection, it may be noted that this test was the least verbal of the four used. Brigham (1923) described this test as being almost entirely independent of the use of language, so that it is possible that performance on this test might have little relationship with func-

tioning on the other three tests of abstraction whose verbal component is much greater.

The small verbal component of the Number Series Completion Test may help to account for the discrepancy between the results of this test and the other three tests. However, the difficult question remains as to why the adventitiously blind did so poorly that their performance was significantly below that of the sighted. No theoretical basis for expecting such results had been provided in previous research.

A possible explanation was brought forth in interviews with the adventitiously blind and sighted subjects. Some of the latter claimed that they had visualized the numbers in each series as an aid to finding the relationship between them. One of the adventitiously blind subjects thought that some changes in his manner of forming concepts had occurred since the onset of blindness, and he described the change as being mainly a decreased reliance on visual imagery. Worchel (1962) found a high correlation between age at onset of blindness and test scores on a tactual recognition task. Performance on such a task was aided by visual imagery so he concluded that the longer a person is deprived of vision, the less he depends on visual imagery. In other words, richness and vividness of imagery may require periodic stimulation.

In the present study the correlation between number of years of blindness and performance on the Number Series Completion Test for the adventitiously blind group was —.13. When vocabulary scores were held constant, a partial correlation of —.41 was obtained, thus indicating that length of blindness did have some adverse effects on the Number Series Completion Test for the adventitiously blind group. Perhaps, for some of this group the fact that they had become less dependent on visual imagery with increased duration of blindness made this task with numbers a difficult one. For a few others who had not been blind for too long a period, the fact that they were in a period of transition as regards the manner of forming concepts could have added to their difficulty with this test. Such factors may not have been as influential on the other three tests, since the tasks involved did not depend upon visual imagery as much as the Number Series Completion Test did. Furthermore, the congenitally blind and sighted

subjects would always have had a consistent, though probably different, method of handling tasks involving numbers and perhaps were not as confused by this test. Further research with blind subjects is needed with this test before any definite statements can be made.

CHAPTER IV

Discussion of Results

At present most of our knowledge about the functioning of the congenitally blind is based on the opinions of experienced workers in the field. Different writers (Chevigny & Braverman, 1950; Cutsforth, 1951; Lowenfeld, 1955) have stressed the consequences that result from the deprivation of such an important sense as vision from a very early age, but little scientific research has been undertaken to show what are some of the effects of blindness from birth. The dearth of research activity is especially evident in the area of abstract functioning in blind adults and brought out the need for the present study.

In general, the results of the present study were in line with the hypothesis that the congenitally blind group would do less well on the tests of abstraction than the sighted and adventitiously blind groups. On three of the four tests of abstraction the congenitally blind had the lowest mean scores of the three groups. On the Proverbs Test the adjusted mean score of the congenitally blind group was significantly below (at the .01 level) that of the combined score of the adventitiously blind and sighted groups, thus clearly verifying the hypothesis. The mean score of the congenitally blind group on the Kahn Test approached being significantly below (beyond the .10 level) that of the other two groups. There was evidence that the scores of the sighted subjects were lowered because of their being blindfolded on this test, and it could therefore be inferred that a significant difference would have been obtained for the Kahn data if the sighted group had not been penalized. The differences among the groups on the Similarities test were in the hypothesized direction, but they were not significant at the .05 level. Only on the Number Series Completion Test were the results significantly out of line with the hypothesis. The lowest mean score on this test was obtained by

the adventitiously blind group, and this mean was significantly below (at the .05 level) that of the sighted group.

The results of the present study were obtained even though the groups used were equated as regards intellectual level, as measured by vocabulary scores, and as regards the extent of formal schooling. The homogeneity of the groups, not only on the above two factors but also on other background variables, militated against obtaining significant differences on the tests of abstraction. Thus, the consistency found in the present results and the fact that some significance was found are noteworthy. It should also be pointed out that the mean vocabulary scores and levels of education of the three groups were above the average level. Moreover, the distributions of the groups on these two factors were negatively skewed which provided further evidence of the selected nature of the groups in the present study. Perhaps, with less homogeneous subjects and with groups having normal distributions of vocabulary scores and of years in school more significant results might have been obtained than those which were found with the groups in the present study. However, the present investigation may be interpreted as pointing to a deficiency in abstract ability in congenitally blind subjects.

Related Findings in the Field of Blindness

It is recognized, as Carroll (1961), Lowenfeld (1955), and others have pointed out, that the mental functioning of the congenitally blind is different from that of the sighted. Cutsforth (1951) also has stressed the point that the sensory equipment and processes of observing of the congenitally blind are organized quite differently from those of the sighted. Senden (1932) reported the first visual perceptions of 66 patients who had regained their sight through surgical intervention for congenital cataracts. The fact that these newly-sighted patients needed a great deal of learning before they could perceive even simple figures gave evidence of a different manner of forming concepts by the congenitally blind than by sighted people. Except for Senden's report most of the information about any differences in the mental functioning of the congenitally blind is based upon the opinions of people working in the field of blindness. Even Senden's work was not

part of a carefully designed experimental plan, and the evidence that it provided was only fragmentary and suggestive (Dember, 1960). However, the present study, using comparable groups of blind and sighted adults, pointed to differences between the congenitally blind and sighted groups in a specific area, that of abstract ability.

The present results also serve to confirm the thinking of Cutsforth (1951), Lowenfeld (1950), and others who have called attention to the restrictions imposed on sensory experience by loss of sight from birth. In a similar vein Omwake and Solnit (1961) pointed out that the congenitally blind lacked an important perceptual organizer. In accordance with this line of thinking, the congenitally blind child would have considerable difficulty in transforming perceptual experiences into mental representations, obstacles to the development of a capacity to organize and store such psychic representations would be created, and concept formation would be late in developing. Hayes' findings (1941, 1950a) that blind children tended to obtain lower scores than sighted children on reasoning tasks, and the results of Axelrod's study (1959) which showed that early-blind children were less efficient than sighted ones on auditory and tactile tasks which were abstract in nature, were in agreement with Omwake and Solnit's hypothesis. The results of the present study indicate that deficiencies in concept formation in the congenitally blind persist into adulthood.

Related Findings in Other Areas

Hebb's work (1949) can also be considered as having some relevance to the results of the present study. Hebb postulated two different visual processes, figural *unity* and figural *identity*. The former was the mere detection of the existence of a figure, that is, the figure standing out from its background. Figural identity required the recognition of the object as a member of a class of figures. Hebb interpreted Senden's data (1932) as showing that the newly-sighted patients were capable of the perception of unity but that they required a long and difficult period of training before figural identity approximated that of persons with vision all their lives. Hebb inferred from this difficulty in learning that the

same learning is equally difficult for normally developing human infants, and that a background of visual learning, simple in nature, is necessary before visual discrimination can be acquired. Attempts were made with animals to reproduce experimentally the conditions under which the human subjects in Senden's report developed.

Hebb (1937a, 1937b) investigated the effects of visual deprivation in infancy on the functioning of rats. From these studies he postulated the concept of the A/S ratio, which is the ratio between the area of the cortex with presumed associative function and the area of the cortex concerned directly with either receptor input or motor output. Hebb found that the rats deprived of visual stimulation from birth needed six times as many trials to learn a visual discrimination task as rats normally reared, but that the difference in performance between the two groups was not lasting. The results indicated that the effects of visual deprivation in infancy were temporary, at least in rats. However, since the A/S ratio of the rat's brain is small, Hebb inferred that visual deprivation during infancy might well have a relatively more marked and more lasting effect upon the behavior of higher animals, that is, animals with a higher A/S ratio.

Riesen's results (1949, 1950) with chimpanzees showed that the effects of visual deprivation in infancy were more lasting in primates than in rats. The chimpanzees deprived of early visual experiences appeared in time to catch up in efficiency with those animals which suffered no infantile deprivation, but their progress was slower when compared with the rats in Hebb's investigations. The results of the visual deprivation studies with rats and with chimpanzees, and Senden's data provide some phylogenic generality to Hebb's theory.

Perhaps even more pertinent to the present results than the deprivation studies are the enrichment studies with animals undertaken by Hebb (1949), Thompson and Heron (1954), and others. Hebb (1949) found that rats reared as pets were able to perform much better on the discrimination tests than rats from the same litter who were raised in the laboratory. Moreover, instead of the cage-reared animals coming closer and closer to the level of the pets as testing continued, the latter rats actually im-

proved their relative standing during the last 10 days of testing. Hebb interpreted these results as indicating that "the richer experience of the pet group during development made them better able to profit by new experience at maturity" (1949, p. 299).

Thompson and Heron (1954) investigated the performance of Scottish terriers on various problem-solving tasks. The dogs were submitted to three degrees of restriction in early experience: some were reared in cages with complete isolation from other dogs and from human beings, after weaning and up until eight months of age; others were ra..ed in ordinary laboratory cages; and those in the third group were reared as pets in homes, from weaning until eight months of age. At about 18 months of age, after the groups had shared 10 months of living in the laboratory, all the dogs were tested on various problem-solving tasks. The results showed that the restricted animals made more errors than the pet dogs on all 18 problems. The fact that the pet dogs remained so markedly superior to the other dogs even at the age of one and a half years suggested that the effects of restricted early experience on problem-solving may be relatively permanent in animals with a high A/S ratio. The results of the Thompson and Heron study create the impression that the effect of restricted experience on the dog is greater than that on the rat, thus tending to confirm the contention that the degree of effect of infantile experience on problem-solving behavior increases with the A/S ratio.

In the light of the findings of these animal studies it is interesting to bring in the results both of Axelrod's study (1959) that children blinded very early in life were less proficient at abstract tasks than sighted children, and of the present investigation that the congenitally blind group tended to do less well than the sighted group on the tests of abstraction. Perhaps the loss of sight very early in life, which is definitely a deprivation of sensory experience, has a more lasting effect in human subjects than in animals. In Axelrod's study and in the present investigation verbal ability was controlled, so that it may be concluded that the effects of visual deprivation from birth in humans can be compensated for in some areas of intellectual functioning, for example, in the learning of vocabulary, but in other areas a lag in proficiency may remain in congenitally blind persons.

Piaget's work can also be considered to have some relevancy with the present results. Piaget (1936) hypothesized that the more new things an infant has seen and the more new things he has heard, the more new things he is interested in seeing and hearing. It is an explanation which is consonant with Hebb's formulation concerning the effects of early sensory deprivation in animals. At the human level, observations on the development of infants reared in orphanages give further support to Piaget's hypothesis. The small number of persons available to care for the infants in an orphange can hardly be expected to supply the degree of environmental stimulation that is available in the home. Skeels, Updegraff, Wellman, and Williams (1938) and Spitz (1945, 1946) have reported lags in the development of locomotor functions in children in orphanges. Dennis (1960) reported even greater retardation in development for the inmates of an orphange in Teheran. Since the congenitally blind group was deprived of such an important source of sensory stimulation from birth, Piaget's hypothesis can be considered as pertinent to the present hypothesis.

A further factor to be considered is the attitude of the people in the environment toward the blind. Foulke (1962) was of the opinion that it is not only the nature of this sensory deprivation, but also the reactions of society to the blind person which brings about a restriction of sensory experience. In the light of the emphasis placed on early sensory experience by Hebb and Piaget, and the results of the present study, the attitudes and feelings of persons in the environment, especially of the parents, toward the blind infant would seem to be of great importance for the future functioning of the infant. Lowenfeld (1956) described the initial feelings of the parents of a blind baby as being those of confusion, anxiety, desperation, and, sometimes even guilt. In many cases the parent's natural devotion to their offspring and the baby's own attractiveness help them in this time of crisis. However, if the blind infant is to realize his true potential, then it seems important that outside professional help be provided to the parents, not only to help them to overcome their own reactions, but also to aid them in finding suitable means of providing sufficient sensory stimulation for the infant's optimal development.

Similarly, the attitude of the school and the teachers would be important for the intellectual development of the congenitally blind child, especially since the present trend is to educate the visually handicapped in regular schools. Perhaps increased training on reasoning tasks in the early school years and efforts to provide a richer multi-sensory approach to learning would be beneficial to the blind student. Moreover, it could be important to give consideration for any deficiencies in abstract functioning which might be found in the school work of the blind student, lest he be unduly penalized when compared to his sighted classmates.

Suitability of the Tests for Use with the Blind

Three of the four tests of abstraction, the Proverbs Test, Kahn Test, and Number Series Completion, had not previously been used with blind subjects. The only change in the administration of the Proverbs Test was that it was given orally and the examiner recorded the subjects' responses. On the Kahn Test it was necessary to alter the instructions and to use a wooden strip, instead of a cloth one, on which the subjects arranged the objects. The wooden strip was exactly the same size and had the same number of equal-sized segments as the cloth one. There were also ridges in the wooden strip which enabled the subjects to determine the boundaries by tactual means. The sighted subjects were blindfolded in order to ensure that both the blind and sighted had the same cues while taking the test. Otherwise, the administration of the Kahn Test was the same as in the manual. The Number Series Completion Test was modified more than were any of the other tests in the present study. Ordinarily, this test is presented visually to the subject and it is a timed test, but because blind groups were used in the present study the Number Series Completion Test had to be given orally to the subjects. An attempt was made to control response time by having a time limit, five seconds per item for the first ten series and ten seconds per item for series eleven through twenty, in which the correct answer had to be given for the series of numbers.

In general, the three tests appeared to be suitable for use with blind subjects. The Proverbs Test was the least altered of the

three tests. Comparing the reliability coefficients between the two forms of the test obtained for the blind groups, it was found that both were the same as those obtained by Gorham (1956b) with sighted subjects. Thus, from the standpoint of reliability the Proverbs Test could be considered suitable for use with the blind. No attempt was made in the present study to investigate the value of this test to bring out projective material in different emotional areas, but from some of the responses of the blind subjects this area appeared worthy of further study.

Modifications were necessary both in the test material and the administration of the Kahn Test, but the task and scoring procedures remained basically the same. The modifications not only made it possible to administer the test to nonseeing subjects, but also with the wooden strip simulated the usual presentation of this test in all essential respects. It was not possible to obtain any reliability data for this test, but the interscorer correlation for the records of the congenitally blind group was similar to that obtained by Kahn (1957).

The mean scores of the two blind groups and the blindfolded sighted groups were within the high average and superior category according to Kahn's classifications (Kahn, 1957), which is what would be expected of these groups in the light of their educational level and vocabulary scores. Thus, the modifications of this test in the present study did not seem to have an undue effect on the performances of the groups or to lower the scores to any large extent. Thus, the modified version of the Kahn Test used in the present study appears to be a suitable instrument for measuring abstract ability in the blind. The fact that this is a nonverbal test increases its value for use with blind subjects. Moreover, future research might also investigate some of the projected aspects of the Kahn Test with the blind.

The administration of the Number Series Completion Test was altered more than the other two tests, since it is normally given by presenting the series of numbers visually to the subjects. However, the high correlation, .88, obtained between the oral and visual administrations to the sighted group, indicates that the oral presentation is tapping similar areas of intellectual functioning as the visual one. The mean scores of the groups in the present

study were above average when compared with the data obtained by Yerkes (1923), which was to be expected considering the intellectual and educational levels of the groups. Futher research with this modification of the test might be helpful in discovering more about abstract ability in the blind, especially in the nonverbal area.

One important factor which the present results point out is that age at onset of blindness should be considered when interpreting test scores, especially if abstract ability is important to performance on the test. Few of the present tests standardized on blind populations have given this factor sufficient attention. If such tests are to be considered valid indicators of the functioning of the blind, then research dealing with the factor of age at onset of blindness may be needed. Shurrager (1962) recognized the importance of this factor, and although it was not included in the first standardization of her performance scale for the adult blind, she planned to consider it in later research with this scale.

CHAPTER V

Summary and Conclusions

A review of the literature revealed that little work has been done in the area of abstract functioning in the blind. A few studies with blind children found that those blind early in life tended to do less well on reasoning tasks than sighted children. Many workers in the field of blindness are of the opinion that deprivation of sight early in life places definite restrictions on the range of the individual's experiences, and can therefore bring about deficiency in concept formation. The present study was undertaken to test the hypothesis that the performance of congenitally blind adults on measures of abstract ability would be significantly below that of adventitiously blind and sighted persons.

The three groups used in the present study were: (1) the congenitally blind group which consisted of those who were blind from before age one; (2) the adventitiously blind group which was composed of those who had become blind sometime after age 12; and (3) the control group of sighted persons. In each of the blind groups there were 23 subjects who were totally blind and two who had only light perception. The blind groups were also equated with respect to cause of blindness to the extent that persons with central nervous system pathology were excluded. Each group was composed of 25 subjects, and all three groups were equated as regards sex, age, education, socioeconomic level, and birthplace of parents.

The author administered four tests of abstraction individually to each subject. The tests included the Similarities test of the WAIS, the Proverbs Test, and adaptations of two other tests, namely the Kahn Test of Symbol Arrangement and the Number Series Completion Test from the Army Alpha Examination, Form 9. The WAIS Vocabulary test was used to provide an estimate of intellectual level, and the mean scores of the groups were not

significantly different from each other on this test. However, since the correlations between the Vocabulary test and the four tests of abstraction ranged from .48 to .74, it was decided to use analysis of covariance in order to correct the means of the tests of abstraction for the small differences in vocabulary scores. The total scores for the groups, adjusted for the differences on the Vocabulary test, were compared in order to determine (on the basis of one-tailed tests) if there were any significant differences in the performances of the groups on the tests of abstraction. Orthogonal comparisons were used since they are permissible even when a significant *F* ratio is not obtained in the analysis of covariance.

The following conclusions can be drawn from the results of the present study:

1. The fact that the mean scores of the congenitally blind group were the lowest of the groups on three of the four tests of abstraction provided some consistency to the results in line with the hypothesis.

2. On the Proverbs Test the performance of the congenitally blind group was significantly below that of the sighted group, thus providing clear verification of the hypothesis. A similar conclusion was suggested by the results of the Kahn Test.

3. The results of the Similarities test were in the hypothesized direction, but the differences among the groups were not significant at the .05 level. The limited discriminative ability of the responses on this test probably decreased its sensitivity to any deficiencies in abstract ability for the groups in the present study.

4. The Number Series Completion Test was the only test whose results were not in the hypothesized direction, as the adventitiously blind group had a mean score significantly below (at the .05 level) that of the sighted group. The importance of visual imagery to performance on this test may have adversely affected the score of the adventitiously blind. Further research with the present modification of this test is needed before any definite statements can be made.

5. The modification of the Kahn Test used in the present study made it possible to administer this test to blind subjects, and the results indicated that the Kahn Test is a suitable instrument for measuring abstract ability in the blind. In view of the need

for projective tests for use with the blind, it might be feasible to investigate the value of the Kahn Test in this area in future research.

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APPENDIX A

Age at Onset of Total Blindness and Number of Years of Total Blindness for the Adventitiously Blind Group

Subject	*Age at Onset*	*Number of Years*
1	14	11
2	22	10
3	24	6
4	22	17
5	16	22
6	12	10
7	21	10
8	15	22
9	12	9
10	12	35
11	25	10
12	12	32
13	21	19
14	13	6
15	28	3
16	31	10
17	35	6
18	17	16
19	13	6
20	14	5
21	14	15
22	17	13
23	13	19
24	21	13
25	23	3

APPENDIX B

Causes of Blindness for the Congenitally Blind and Adventitiously Blind Groups

Cause	*Congenital*	*Adventitious*	*Total*
Accident	2	7	9
Bechet Syndrome		1	1
Cataracts		4	4
Congenital Cataracts	2		2
Choroiditis		1	1
Coloboma	1		1
Conjunctivis	1		1
Detached Retina		3	3
Glaucoma		2	2
Congenital Glaucoma	3		3
Glioma	1		1
Inflammation of the Eyeball	1		1
Ophthalmia Neonatorum	2		2
Optic Nerve Atrophy	2		2
Retinal Blastoma	1		1
Retinal Hemorrhaging		1	1
Retinitis Pigmentosa	1	2	3
Retrolental Fibroplasia	4		4
Sympathetic Ophthalmia		3	3
Unknown	4		4
Uveitis		1	1

APPENDIX C

Number of Years in Residential Schools for the Congenitally Blind and Adventitiously Blind Groups

Subject	*Congenital*	*Adventitious*
1	12	2
2	0	0
3	3	0
4	1	0
5	11	0
6	11	6
7	8	0
8	7	0
9	2	1
10	12	8
11	8	0
12	9	0
13	12	0
14	10	1
15	12	0
16	0	0
17	2	0
18	12	4
19	12	5
20	8	4
21	0	8
22	8	0
23	0	0
24	12	0
25	12	0

APPENDIX D

Individual Scores on the Vocabulary Test and the Tests of Abstraction for the Congenitally Blind, Adventitiously Blind, and Sighted Groups

N	*Vocabulary*			*Similarities*			*Proverbs*			*Kahn*			*Number Series*		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1	18	17	17	16	13	12	40	41	31	157	130	107	15	8	9
2	17	17	16	11	11	18	39	34	36	124	142	112	15	7	16
3	17	16	15	17	17	16	30	33	36	129	100	115	19	15	18
4	16	16	15	12	14	13	33	39	34	98	112	142	14	17	17
5	15	16	15	12	14	13	29	31	13	106	139	137	10	11	18
6	15	15	15	13	13	13	30	35	35	147	114	92	17	13	19
7	15	15	15	12	13	13	24	37	37	108	149	115	1	13	13
8	15	15	15	13	14	11	29	27	40	107	111	149	18	12	12
9	15	14	14	11	13	13	12	32	35	62	114	96	9	15	11
10	15	12	14	11	13	16	29	28	35	51	130	120	17	9	19
11	14	12	14	11	12	12	38	25	30	114	109	111	17	10	20
12	14	12	14	12	10	13	25	16	36	158	102	120	17	5	13
13	14	12	13	15	10	15	31	37	36	109	112	125	14	9	15
14	14	11	13	12	13	13	26	30	35	114	126	98	10	9	17
15	14	11	13	12	12	12	24	22	33	134	128	118	12	14	13
16	14	11	12	12	10	11	34	20	27	106	120	98	9	12	13
17	13	11	12	14	14	13	32	19	30	70	99	71	11	9	14
18	13	11	12	11	13	12	23	19	35	80	143	132	18	12	13
19	12	10	11	12	12	13	36	30	29	122	92	115	18	11	10
20	11	10	11	13	10	11	22	23	23	148	121	102	12	14	7
21	10	10	11	4	12	13	11	21	32	75	95	97	1	12	15
22	9	10	11	12	13	10	22	25	27	61	100	121	14	13	15
23	9	9	9	14	12	6	14	23	25	107	106	118	12	8	12
24	7	8	8	8	8	12	6	12	15	58	72	103	2	6	10
25	5	5	5	5	2	6	4	9	3	52	46	75	3	5	2